Improvement by nature

The main difference between feeds for aquaculture and livestock feeds is of course that aquaculture species are fed under water. This fact has important consequences on the engineering of those feeds. Producing feeds for aquaculture species has not only a nutritional factor but also an important functional factor.

Depending of the feeding habits of the targeted species, feeds should float, sink, sink slowly, absorb water, leach controlled substances to attract the animal. This can be controlled by the production method and parameters, but also through formulation. Some ingredients are added to feeds which are mostly functional but have little or no nutritional value. One such ingredient is the binder. Binders generally form a network through the feed pellet and holds it together while it interferes with the water.

Comparison of binders

The mostly used binders are ureaformaldehyde, wheat gluten and gelatine. Binders from algae such as carrageenan and alginates are sometimes used but their cost limits the application to larval diets. Gelatinizing the starch is often used to improve water stability. However, this is achieved by excessive heating through preconditioning, postconditioning or extrusion. Meanwhile, the quality of other ingredients can be affected.

Another disadvantage of most binders is that they are only functional once. Gelatinized starch, wheat gluten and ureaformaldehyde will not work anymore once heated and cooled down. This limits the amount of reworks that can be used in the factory. Alginates and gelatine can be heated and cooled down several times and will keep their functionality. Ureaformaldehyde is a pure synthetic binder with no nutritional value. It can not be digested by fish or shrimp. It is prohibited in the EU. However it is widely used in Asia and North and South America.

In the process, formaldehyde is bound to the NH2 group of Urea to form a polymer. However, the formaldehyde can also bind to other amine (NH2) groups in other products such as melamine or amino acids. Formaldehyde is a cross-linking agent to inactivate, stabilise or immobilise proteins. Formaldehyde was shown to react with the amino group of the N-terminal amino acid residue and the side-chains of arginine, cysteine, histidine, lysine residues. Because of its high N content (39%, corresponding with 146 % of crude protein), urea-formaldehyde increases the level of crude protein in feeds, but of course is not a real protein. Recently, it appeared that commercial brands of Ureaformaldehyde-based binders also contained melamine.

Pro-Bind Plus

Advantages of a gelatin-based binder in aqua feed
Dominy et al (2003) compared different commercial binders for water stability, leaching and performance in shrimp feeds. Diets with binders based on urea-formaldehyde had a lower leaching rate than other, especially for proteins, but the shrimp performance was also less. The water stability of natural binders (natural milo grain, wheat gluten, guar gum, vegetable wax, bone meal and blended ingredients) differed a lot, but all had good growth responses from the shrimp. The diets with binders containing urea-formaldehyde performed generally very well for water stability and leaching, but their growth response was inferior compared to other binders. Natural binders showed the best growth although other synthetic binders (not containing urea-formaldehyde) also performed well. It seems that UF has a negative influence on growth.

**Pro-Bind Plus: the concentrated, nutritional pellet binder**

Pro-Bind Plus is a gelatin based binder. It originates from non-ruminant gelatine. It has a very high protein content (85%). The pepsine digestibility of gelatine is close to 100 %. Lemos analyzed Pro-Bind Plus with the pH stat method for Litopenaeus vannamei and found a degree of hydrolysis (DH%) of 9,77 %, which is extremely high.

Three levels of Pro-Bind Plus (0,25 - 0,5 - 0,75 %) have been compared with a feed without binder and one with ureaformaldehyde. Feeds were passed a three-phase preconditioner at 80°C. Feeds were pelleted through a die of 2,2 mm and kept in a postconditioner for 20 minutes. There were no differences in pellet resistance against wear among treatments for the Phost test. Dust production after tumbling was less than 3 % for all treatments. However, the Kahl test showed that pellet hardness increased from 2,7 (no binder) to 3,4 (Ureaformaldehyde) and 3,8 - 4,4 and 4,8 for inclusion of Pro-Bind Plus at 0,25 - 0,5 - 0,75 % respectively (see figure 2).
Water stability

When reacting with water, feed absorbs water and leaches substances. An important function of the binder is to keep the integrity of the pellet so that this leaching is reduced as much as possible. In another trial, Pro-Bind Plus was compared with Lignosulfonate and Carrageenan. All feeds showed about the same amount of leaching, but the cost of inclusion was much lower for Pro-Bind Plus and Lignosulfonate.

Role of hydroxyproline

Researchers from Fiskeriforskning recently detected that hydroxyproline improved feed consumption in salmon, and also growth. It is assumed that the role of hydroxyproline as building block for collagen formation was underestimated. The results also indicate that feed with more hydroxyproline causes fewer deformations in the bone structure.

Ascorbic acid functions as hydroxylation of proline to hydroxyproline, which in turn is an important building block for collagen formation.

Gelatin contains high amounts of both Hydroxyproline (11.5 % of proteins) and Proline (13.1 % of proteins), and could play an important role in collagen formation of fish and shrimp.

When formulating diets, it is always interesting to reduce the amount of non-nutritional ingredients. Therefore, Pro-Bind Plus offers a valuable and safe alternative to synthetic binders.

The advantages of Pro-Bind Plus®

- high nutritional value
- source of the semi essential amino acid hydroxyproline
- 100% natural (contains no melamine or urea)
- low inclusion
- cost effective
- EU and USA approved
Figure 4: Semi-intensive farming of shrimp requires water stable diets, since shrimp are only fed 3-5 times a day, and feed remain in water for longer periods.

Figure 5: For the production of water stable shrimp feeds, pellet mills are equipped with triple preconditioners to allow gelatinization of the starch.

Reference cited: